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Analytical and numerical investigations of imbibition in porous media

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The multiphase flow of fluids in a porous media is attributed to viscous, gravitational and capillary forces. A theory was proposed by Buckley and Leverett for viscous dominated flow during the last century which is used to estimate the rate at which the injected water moves through a porous medium. In this work, we study and investigate the phenomenon of imbibition which is the taking up of a wetting liquid by a porous solid. We present analytical and numerical solutions for spontaneous imbibition in one dimension by the use of fractional flow theory. The solutions can also be understood as the capillary analog to the classical Buckley Leverett solution and are valid for co-current displacement, with arbitrary fluid viscosities, as well as for capillary pressure and relative permeability curves dependent on saturation. We measure the saturation profiles as a function of distance and time in fluid-filled porous media with some initial wetting fluid saturation. We create a 1-D model on a numerical simulator to simulate and obtain saturation profiles for the different wettability cases assuming horizontal immiscible displacement in porous media. We then match simulation results with saturation profiles obtained through the capillary dominated flow semi-analytical solution proposed in literature. The solution can be used to study the influence of wettability, predicting saturation profiles and production rate characteristics.

Participation

In-Person

References

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